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Public Welfare Service

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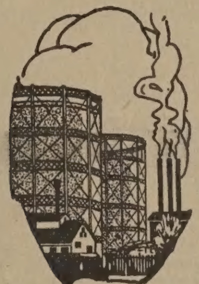
1927

MANUFACTURED GAS



How It Is Made and Delivered to the Customer

For Use of School Students, English and Current Topics Classes, and Debating Clubs

Issued by
ILLINOIS COMMITTEE on PUBLIC UTILITY INFORMATION
79 West Monroe Street - - - - - Chicago, Illinois

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INTRODUCTORY

Lighting methods were exceedingly primitive until a little more than a century ago when manufactured gas first was used successfully for artificial illumination. Although gas was discovered about the middle of the Seventeenth Century, it was not until the later years of the Eighteenth Century and the beginning of the Nineteenth that man learned how to make it serve a useful purpose.

The introduction of gas lighting marked an important epoch in the progress of civilization. Gas was the first of the number of great discoveries and developments which made possible, during the last century, greater progress and development in the world than in all the thousands of years of civilization which had preceded it.

Gas Companies First Utilities:

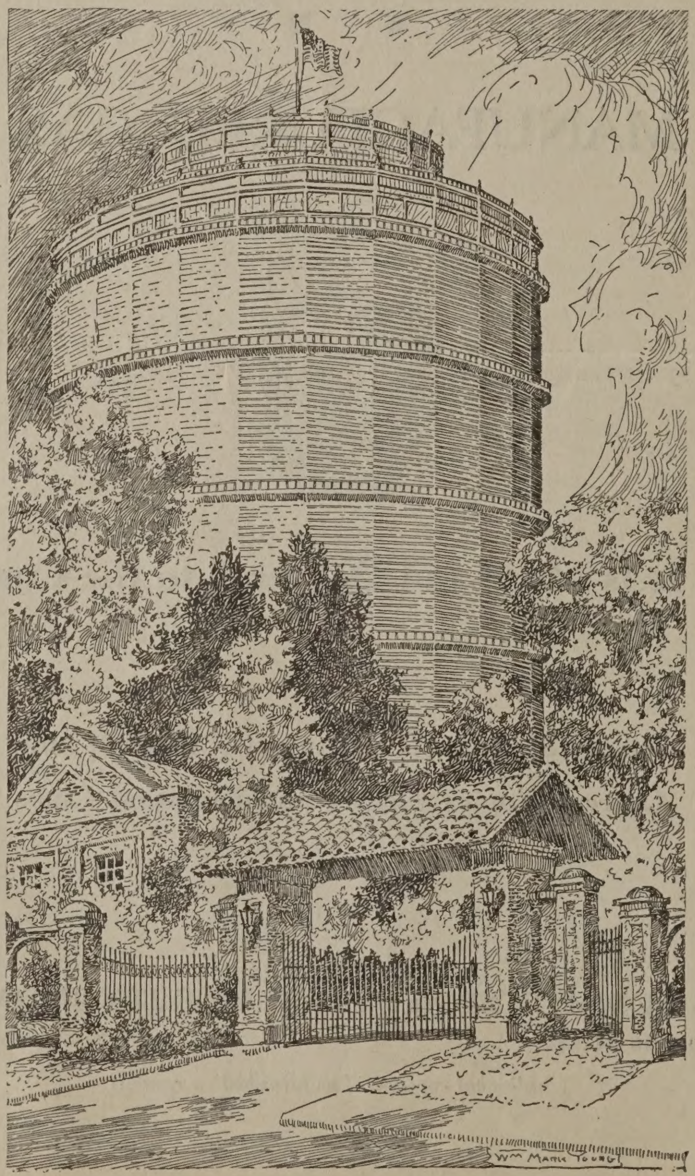
Companies organized for gas-lighting were the first of what are now commonly known as public utilities. Electric light and power, telephone and electric railway companies followed at later dates. Today, these public utilities represent an investment in plants and equipment of about $23,000,000,000 in the United States alone.

For more than 100 years gas has lighted the way of progress. It was used first for streetlighting. Later, public buildings and homes were lighted with it. In fact, for nearly 75 years, this was practically its only use. Then came electricity. It threatened to take the place of gas lighting. The "Welsbach mantle" which gave six times more light than the open flame burner was perfected in 1896 and gas lighting held its own against electricity for many years. About the same time, gas came into quite general use for cooking. Today it cooks the meals for half of the people in the United States, and it is used for house heating, incineration, refrigeration, water heating, garage heating and has thousands of uses in industry.

Gas and Electricity Not Competitors:

Despite the rapid development of the use of electric light and power, new uses for gas have increased its consumption every year, the consumption today being double what it was ten years ago and more than three and one-half times what it was twenty years ago. Electricity and gas are not competitors in the strict sense of the word, electricity being used chiefly for light and power and gas for heat. There are some instances where they overlap, but speaking broadly, each has its own field.

Gas, long the servant of the housewife, is now being utilized by industry on a scale never before thought possible. The industrial use of it, a development of the last decade, is revolutionizing industry. The next great step in progress will be the heating of cities with gas and coke, the latter a by-product of gas making. When this is done, smoke will be driven from the cities and the nation's fuel resources conserved.



MODERN GAS HOLDER

GAS — The Modern Fuel

The Discovery of Gas:

John Baptist van Helmont, of Brussels, who made some of the earliest and most important contributions to modern chemistry during the Seventeenth Century, was the discoverer of gas. He studied and practiced medicine and later turned to chemistry and research work. He dedicated himself at first to alchemy and is numbered among the last of that line of philosophers who labored in vain in the eternal hope of making gold. Although a member of a wealthy and ancient family, he preferred his laboratory at Velvorde to all the state and splendor of the court and eventually abandoned alchemy and turned to a more rational philosophy and research work.

In the course of his experiments with fuels, about 1609, he discovered that they yielded up what he described as "a wild spirit." He found that this "spirit" could be produced in various ways: combustion, fermentation and the action of acids on limestone.

In writing of his experiments he said "seventy-two pounds of oak charcoal gave one pound of cinders and the seventy-one pounds remaining served to form the spirit Sylvester." He remarked "there are bodies which contain this spirit, of which they are almost entirely composed, and is therein fixed and solidified, and are made to leave that state by fermentation, as we observe in the fermentation of wine. This spirit, up to the present time unknown, not susceptible of being confined to vessels, nor capable of being produced in a visible body, I call by the name of gas."

Name Delays Development:

So phantom-like and elusive was van Helmont's discovery that he named it after "geist," the old German word for spirit. Thus, at its very christening, gas was enshrouded in a veil of mystery that for many generations was to obscure it and carry the suggestion of intangibility to the superficial mind in an age of superstitions.

In fact, it was nearly 200 years after van Helmont's discovery that practical steps were taken to harness this elusive spirit and make it serve a useful purpose.

Although van Helmont recognized the existence of various gases, he perfected no way of confining them and it remained for later adventurers into the realm of chemistry research to perfect methods of storing the gas after it was made, thus opening the way to its later usefulness to mankind.

A few years after van Helmont made his discoveries and while other chemists were endeavoring to become acquainted with the hidden laws of nature, natural gas was discovered in various places in England. These discoveries attracted wide attention.

Discovery of Natural Gas:

The earliest description of these finds is in a communication to the Royal Philosophical Society of London in 1667 by Thomas Shirley, in which he mentions that his attention was directed about eight years previously to what was considered to be a spring "where the water did burn like oyle" and "did boyle and heave like water in a pot." Upon investigation, he found this to "arise from a strong breath, as it were, a wind which ignited on the approach of a lighted candle," and "did burn bright and vigorous."

Natural gas was discovered in other parts of the world, and in many instances it was believed to be the work of a supernatural agency and, in some places where the gas became ignited, causing continuous fire, fire-worshippers erected temples.

In Greece, one summer afternoon several centuries ago, a herdsman was tending his goats. He noticed that some of them wandered about in an unusual manner whenever they came to a certain spot. He walked over to investigate the cause of their peculiar behavior and became affected himself by something which arose from the ground. He ran to the village and told his neighbors. They hurried back in great excitement and all had the same experience. They became talkative and light-headed. They acted queerly and their conversation was disconnected and difficult to understand. The villagers agreed that they were in the presence of a supernatural agency and decided that a god was living there. Later, they appointed a priestess to communicate with this god and built a temple where persons might go for advice. Thus, the Oracle of Delphi became famous.

Gas and The Oracle of Delphi:

The gas at Delphi is thought to have been natural gas. This gas was found in many parts of the world, but it was many centuries before its value was understood and utilized.

Long before manufactured gas was produced by van Helmont and the natural gas wells began to attract attention in Europe, the Chinese are said to have utilized natural gas. Discovering it during a period of Chinese development, which later deteriorated, the Chinese piped the gas through tubes of bamboo and used it for lighting, but it never became of popular or general use.

Dr. John Clayton, a Yorkshire minister with a liking for the sciences, robbed the spirit of some of its elusive qualities and brought it within the realm of practical things by experiments con-

ducted from 1660 to 1670. He found at Wigan what he described as a "shelly coal." Heating this coal in a closed vessel, he found that a "spirit which issued out caught fire at the flame of a candle."

Superstitions Block Progress:

Although Dr. Clayton succeeded in producing van Helmont's "wild spirit" from coal, he, too, failed to turn gas to practical use.

Progress in the development of gas was slow. Civilization had passed through the sperm oil age of lighting to the age of the wax and tallow candle, which was still the common method of illumination late in the Eighteenth Century, when William Murdock devoted himself to the task of producing gas from coal on a scale that would make possible its use for lighting. By distilling coal in an iron retort and conducting the gas through 70 feet of tinned and copper tubes, Murdock, in 1792, succeeded in lighting his home at Redruth in Cornwall.

Murdock was a construction and erection engineer for James Watt, developer of the steam engine. In 1798 he had progressed so far that he moved from Cornwall to the works of Boulton, Watt & Company, manufacturers of steam engines at the Soho Foundry, where he built an apparatus on a large scale and lighted the factory with gas.

First Successful Gas Lighting:

On the occasion of the celebration of the Peace of Amiens—the signing of a treaty between Great Britain and France, Spain and Holland—in April, 1802, a public display of the new light was made which attracted wide attention and comment. Matthews, one of the earliest writers on gas lighting, in describing this spectacle, says:

"The illumination of the Soho Works on this occasion was one of extraordinary splendor. The whole front of that extensive range of buildings was ornamented with a great variety of devices that admirably displayed many of the varied forms of which gas light is susceptible. This luminous spectacle was as novel as it was astonishing and Birmingham poured forth in numerous population to gaze at and to admire this wonderful display of the combined effects of science and art. The writer was one of those who had the gratification of witnessing this first splendid public exhibition of gas illumination and retains a vivid recollection of the admiration it produced."

Murdock was a hard worker and a versatile inventor. He made many important improvements in steam engines, in addition to his development in the use of gas. He introduced the "D" slide valve, which is used in gas meters as well as in steam engines.

On one occasion, it is related, Murdock desired to stop the flow of gas, which was burning from an open tube. To accomplish this, he clapped a thimble over the flaming end of the tube. The thimble had been pierced in many places and the gas coming through the holes in smaller volume was brought into contact with a greater proportion of air at the point of combustion. The result was a much better light. This incident was the origin of the "gas tip" which later came into general use for lighting.

Murdock Father of Industry:

Murdock's achievements were so practical that he is recognized as the father of the gas industry while in France, Phillippe Lebon was the most active and successful contributor. The latter obtained a patent in September, 1799, for making gas by distilling coal or wood and lighted his home and gardens in Paris in 1801.

The art of gas manufacture took definite form after Murdock had blazed the way. The demonstrations of both Murdock and Lebon attracted wide attention and praise by the press and thus came incidentally to the attention of Frederick Albert Winsor, a German, who was destined to play a most prominent part in establishing the first gas company in the world and probably speeding up the general use of gas for domestic purposes.

Winsor's Discoveries Important:

Winsor, who seems to have been more of a promoter than a scientific research worker, journeyed from Frankfort to Paris where he witnessed several times "the wondrous effects of common smoke being made to burn with greater brilliancy and beauty than wax or oil." He endeavored, unsuccessfully, to learn the secret from Lebon. In 1803, at London, he began experiments and demonstrations which led to practical results.

He delivered many lectures and was the first to advocate the distribution of gas for lighting purposes from central sources. He proposed the organization of a company for "enlightening the inhabitants of London," but he stated his claims so extravagantly that much opposition to his plan was aroused.

First Patents Obtained:

May 18, 1804, Winsor obtained the first English patent for gas-making. He gave a public exhibition of lighting the Lyceum theatre in London with gas and the London Times, six weeks later, printed the following description of the demonstration:

"Sir Joseph Banks, ever indefatigable in examining and promoting useful discoveries, went last Thursday evening, for the second time, with a large party of his noble and scientific friends to the Lyceum to witness the incredible effects of

smoke; the whole theatre was lighted with the same, in a novel and pleasing manner; the arch of lights above the stage had a very striking effect, and from the English grate on the stage (which may be fixed in every room) issued a very brilliant and fanciful light. The products of tar, ammonia, and coke were produced and much approved of. Several experiments were made during the course of the lecture, such as boiling a tea kettle and melting ores in a few minutes on a table. It was also proved that a brilliant flame adapted to lighthouses could be formed, which no rain or storm could extinguish. The noble and learned visitors, after a minute examination of the apparatus, stoves and products, expressed the liveliest satisfaction."

Prejudices Delay Progress:

Winsor had a vision of the future of the gas industry, but he was confronted with a Herculean task in fighting against old-established customs and prejudices. All of his predictions regarding the utilization of gas have proved true during the last fifty years. Although gas was used only for lighting for many decades after Winsor established the first gas company more than 100 years ago, he foresaw some of its present-day uses.

"Since the beginning of the world," said Winsor in one of his early appeals, "mankind has lost above eighty per cent in all combustibles by the mere evaporation of smoke. This very smoke, which often proves troublesome and dangerous to health and houses, is now discovered to contain the most valuable substances, and if properly extracted, gathered, washed, purified and resolved, we gain no less than five costly products, viz., oil, pitch, acid, coke and gas; which latter product not only furnishes the most intense heat, and the purest light, whenever it is wanted, but can also be applied to supersede the dangerous and expensive steam-engines, because a celebrated French engineer proves that the azote it produces, by a mixture with the atmospheric air, is capable of tenfold power if employed at the freezing point only."

Winsor Ridiculed:

Winsor claimed that gas could be used for heating as well as lighting and that it would result in a three-fourths saving in the construction of buildings because of the elimination of chimneys, stoves and other equipment used in burning other fuels.

"Nay," he remarked in one of his pamphlets, "it will almost appear incredible to assert that the same table, desk or sideboard, which furnishes a light or flame will serve to warm any room and even dress my victuals in case of need; and, by the mere turning of a cock, or the corking or uncorking of a small pipe or tube."

Not content with exploiting the wonders of gas in prose alone, he sometimes did it in verse. The ardent manner in which Winsor pursued his subject and his extravagant claims of the advantages of gas lighting excited great opposition to his scheme and made him the object of ridicule. Sir Walter Scott, who was much opposed to Winsor's scheme, wrote to a friend, saying: "There is a madman proposing to light London with—what do you think? Why, with smoke."

Napoleon, when he heard of the plan to light London's streets with gas, dismissed the idea as *"une grande folie."* Actors in the music halls poked fun at the tireless inventor and promoter and a writer of humor burlesqued Winsor and his claims in a verse.

Despite the opposition and ridicule, Winsor continued his task and succeeded in getting the support of a large and influential body of shareholders in his company and the first public street lighting with gas took place in Pall Mall in London on January 28, 1807. This demonstration did much to expel many of the doubts regarding the practicability of his discovery.

First Gas Company in 1812:

Winsor sought for his company the exclusive privilege of lighting by gas in all the British possessions, but such a broad charter was refused. In April, 1812, Parliament granted a charter to his company, "The London and Westminster Gas Light & Coke Company," and thus the first gas company in the world came into being.

On December 31, 1813, Westminster Bridge was lighted with gas, and the populace of London was dumbfounded by the spectacle. It was many years before the citizens of that city became accustomed to gas lighting, although it was extended rapidly after the lighting of the bridge. People thought the flame came through the pipes and many objections were raised when the system was installed in the House of Commons. So little was known about gas, it was thought that the "pipes would burn the building" and they were set far away from the walls, and the members of Parliament, fearful of being burned, would not touch them with ungloved hands. Lamplighters at first refused, through fear, to light the new gas lamps, and later crowds followed them to watch their operations every evening.

Following the success of gas lighting in London it spread quickly to other countries. In the United States, Baltimore, in 1816, was the first city to light its streets with gas, and, in 1820, Paris, France, was so lighted.

Little did van Helmont, working in his laboratory in Brussels, discovering the mysterious spirit which he could not imprison, think that his discovery would be the foundation of an industry which in the United States alone today represents an investment of about $4,500,000,000.

First American Gas Company in 1816:

Although there were a few isolated instances of gas being used by individuals in other cities previously, introduction of gas lights in Rembrandt Peale's museum in Baltimore in 1816 proved to be such a sensation and success that it led to the organization of a gas company and the lighting of the streets of that city with gas.

"Gas Lights without Oil, Tallow, Wick or Smoke" in the "Museum and Gallery of the Fine Arts in Holliday Street" was the way Peale made his announcement in newspaper advertisements on June 13, 1816. An admission fee was charged for viewing this wonderful light and people flocked to see it. The exhibition was so successful that talk of lighting the streets of Baltimore began immediately.

The city council passed an ordinance on June 17, 1816, permitting Peale and others to manufacture gas, lay pipes in the streets and contract with the city for street lighting. Thus the first gas company founded in the United States began to operate in Baltimore in 1816. On February 5, 1817, it was incorporated as the Gas Light Company of Baltimore.

First Home Lighted With Gas:

A few years earlier, in 1812, David Melville of Newport, R. I., lighted his home and the street in front of it with gas which he manufactured. He also lighted a factory at Pawtucket and induced the government to use gas at Beaver Tail Light House.

Introduction of gas lighting was not rapid because it was a radical change from the common methods of lighting in those days. It was regarded with fear by many people and as many objections were made against it in the United States as had been made in London when introduced there. A proposal to introduce gas lights in Philadelphia met with strong opposition. In 1830, after gas lighting was used in Baltimore, Boston and New York, Philadelphia still fought against it and "A Public Remonstrance Against Lighting with Gas" was drawn up by prominent citizens who were successful in blocking the progress of street illumination until 1836 when the city finally consented to the use of gas as a substitute for candles, lanterns and whale-oil lamps which were the common methods of lighting in those days.

Many Objections to Gas Lighting:

In New England, the proposal to light the streets of one of the towns with gas aroused a storm of protest. Following are some of the arguments printed in a New England paper, which represented the best and most serious thought of that time.

1. **A religious objection.** Artificial illumination is an attempt to interfere with the divine plan of the world which had pre-ordained that it should be dark during the night time.

2. **A health objection.** Emanations of illuminating gas are injurious. Lighted streets will incline people to remain late out of doors, thus leading to increase of ailments by colds.

3. **A moral objection.** The fear of darkness will vanish and drunkenness and depravity increase.

4. **Police objection.** Horses will be frightened and thieves emboldened.

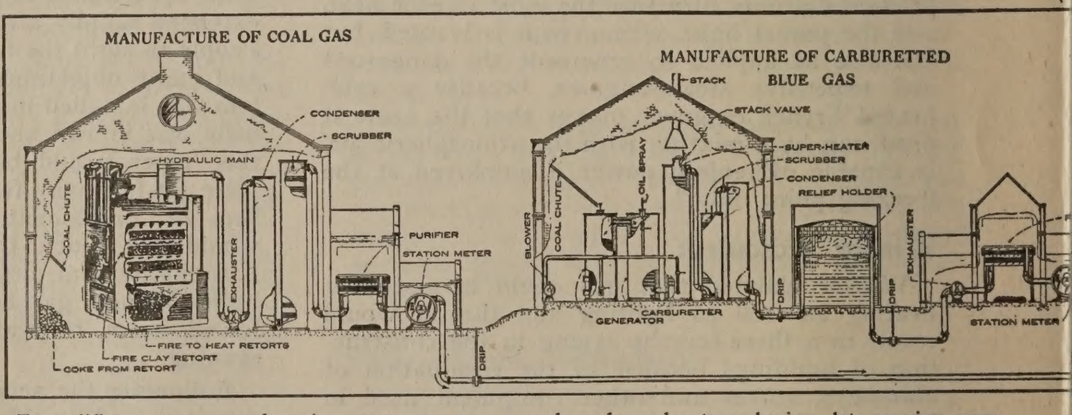
5. **Objection from the people.** If streets are illuminated every night, such constant illumination will rob festive occasions of their charm.

Gas Lighting Spreads:

High rates made gas prohibitive to all but the rich and it was not until the year 1865 that the use of gas for home lighting began to make any great progress.

Gas was introduced in Chicago in September,

How Manufactured Ga



Two different gas manufacturing processes are pictured in the above model. One is the manufacture of gas by the distillation of bituminous coal in coking ovens which makes what is known as coal gas. The other makes gas through what is known as the carbureted blue gas process. Coke and steam and usually an enriching material such as oil are used in making gas by this process. All gas companies do not use both processes. A description of both processes will be found on pages 10 and 11.

Following is a brief description of some of the gas-making and distributing equipment pictured above:

Condenser

This is fitted with tubes surrounded by water and arranged so gas goes through the tubes and the water absorbs the heat in the passing gas.

Scrubber

This consists of a cylindrical tower containing a number of wooden trays having slats running crosswise in checker board fashion and where a water spray at the top of the tower keeps the slats wet and washes the impurities down over the wet surfaces.

Purifier

This is a large box containing two trays of oxide of iron where the sulphur impurities in the gas are absorbed by the iron and removed from the gas. The top or lid of the purifier can be raised, as shown by the dotted lines above, for changing the oxide. A pile of oxide undergoing airing is shown on the floor underneath the purifier.

Gas Holder

This is merely an open top circular tank filled with water in which a smaller open bottom tank is placed so that the gas can fill the space between the water and the top of the smaller inside tank called a "lift."

1850, the city at that time having a population of only 23,047. Admiring crowds of citizens watched the lighting of the gas street lamps nightly. The state legislature, the year previous, had authorized the formation of the Chicago Gas Light & Coke Company. Gas was introduced in Quincy, Rock Island and Springfield, Ill., in 1854, and in Galena, Ottawa and Peoria in 1855. Its use in other cities of Illinois and the country followed rapidly.

Improvements in Light:

In 1855, Robert Wilhelm von Bunsen invented the blue flame gas burner, which is still in use today in many places. With this burner it is possible to burn gas economically with an intensely hot, but smokeless, flame. It was such an improvement over the burners previously used that it was instrumental in giving a great impetus to the use of gas.

Gas lighting spread and was the common means of home illumination in the cities of the land when Thomas A. Edison invented the electric light.

Right at the time when the new electric light threatened to supplant gas, Carl Auer, who studied under Bunsen at Heidelberg, in Germany, made a notable discovery for which he was awarded the title of "von Welsbach" when he gave to the world the incandescent mantle bearing this name, which is used today generally wherever gas is used for lighting.

Auer discovered, accidentally, that certain rare earths glow brightly when subjected to the flame of a gas burner. He experimented and found that by introducing oxides of cerium and thorium on a cotton webbing, as a "mantle" covering or surrounding the gas flame, these substances could be heated to incandescence without losing form or falling apart and then would produce a much better light than the flat flame or slit-tip burner. Such a mantle produced six times as much light and used less gas than did the flat flame burner. But, like all other improvements in lighting, progress in the use of gas mantles was slow and they were not used to any great extent until 1890. Inverted gas mantles were not introduced until 1900. In 1896 the Welsbach mantle was applied to street lighting with success.

At the Centennial Exhibition in Philadelphia in 1876, a baking powder company demonstrated the baking of cake on gas stoves but it was not until about 1895 that any great effort was made to popularize the use of gas for cooking and heating.

Gas in Industry:

The industrial use of gas is a comparatively recent development, this modern fuel finding extensive use in industry only within the last ten years.

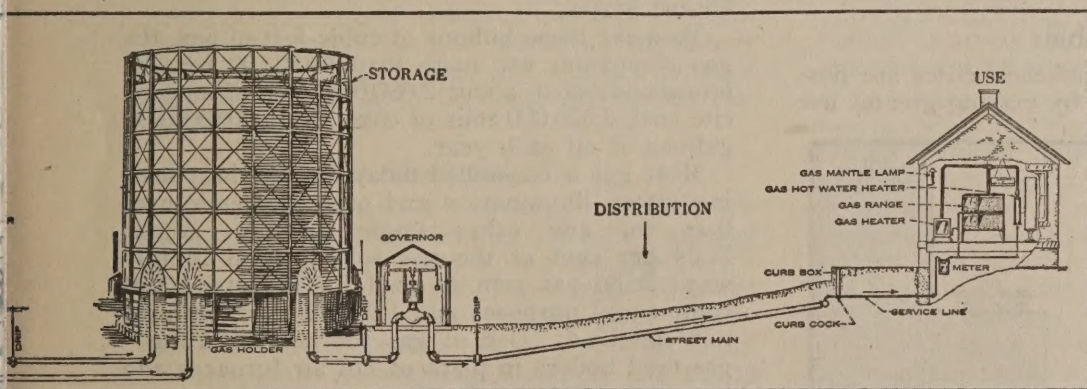
Manufacturers, especially those in the metallurgical industries, discovered gas to be a highly efficient fuel for heat-treating metals. Many other uses have been found for gas in factories, until today it is estimated that there are no less than 60,000 different industrial uses for gas.

The fact that gas is a clean fuel makes it desirable for use in processes where cleanliness is essential to good products. The absence of smoke and soot produces better working conditions in factories where it is used. Gas also lends itself readily to automatic control.

As gas is available by the turn of a lever, factory owners who are using it have no money invested in a fuel supply; they do not worry about changes in the price of coal or oil, nor about railroad congestions and car shortages.

No space is needed for storing fuel or ashes and there is no cost of ash removal, which is a big item when coal is burned. No insurance is necessary on fuel stock and lower insurance rates on plants are obtained when gas is used.

is Made and Distributed



When the gas volume is increased, the lift rises, when the gas decreases, the lift descends. The weight of the lift produces pressure on the gas.

Station Meter
This is merely a large meter which measures the volume of gas manufactured as it goes to the storage holder.

Storage
Gas is made at practically a uniform rate for 24 hours. The rate of use of the gas varies largely during different hours of the day. The function of the holder is to equalize the input and output.

Governor
As the gas comes into the holder and raises the telescoping sections, the weight of the metal that the gas must support increases and this increases the pressure on the gas, therefore the higher the holder is raised the greater must be the resulting gas pressure.

To furnish a more uniform pressure to the consumer, the gas now goes through a governor which is merely a mechanical device where a variable intake pressure is changed to a practically uniform pressure in the distributing mains.

Delivery of Gas
From the governor the gas goes into the street mains, through the curb cock, service line, house meter and to the consumer's appliance.

Like the realization of an alchemist's dream, we have a serviceable transmutation of a baser substance into one of greater value in the unnoticed transmutation of crude, dirty, inert coal into energetic gas which can then be transmitted to a consumer far away where the turning of a gas cock makes it instantaneously available.

Its Many Uses:

Gas is being used extensively today for baking bread in big bakeries, making candy, roasting coffee, smoking meat, pasteurizing milk, pressing clothes, melting glass and many different kinds of metal, vulcanizing automobile tires, drying clothes, drying lumber, forging, heating rivets, galvanizing, welding, cutting metal, annealing, hardening and tempering alloy steel, tool dressing, bolt and rivet making, welding locomotive tubes, heating steel structural materials for fabrication, flanging and bending pipe, plate heating, soft metal melting, aluminum refining, metal cutting, lead refining, silver refining, in treating various metals in ovens and for many other purposes. One Chicago manufacturer uses gas in thirty different processes.

Many modern laundries generate steam by gas, and it is being used more each year in small industrial steam power and heating plants. Likewise each year sees gas used more extensively in the home.

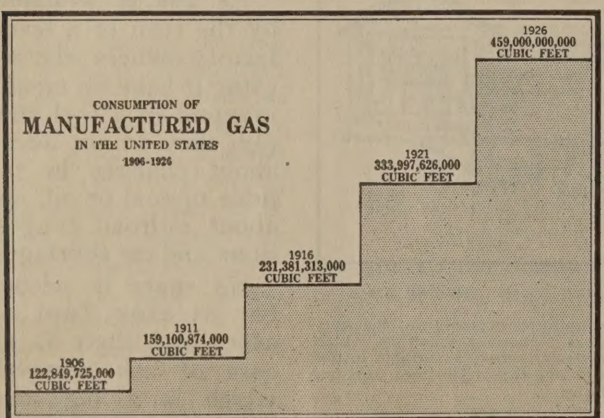
How Coal is Wasted:

Experts estimate that the heat energy of at least 1,800 pounds of coal is lost on an average from each ton of coal mined now in America. In gas making, one ton of coal will produce approximately 1,400 pounds of smokeless fuel (coke), 10,000 to 12,000 cubic feet of gas, 25 pounds of ammonium sulphate, two to three gallons of benzol and nine to twelve gallons of coal-tar.

When coal is used for the manufacturing of gas, two useful and smokeless fuels are obtained: gas and coke, and at the same time, valuable by-products, which otherwise would be wasted, are saved.

Smokeless Cities Possible:

Experts believe that smokeless cities are possible within twenty years by making greater use



During 1926 the people of the United States used 459,000,000,000 cubic feet of manufactured gas—almost four times as much as in 1906. The amount used is increasing each year.

of manufactured gas and coke. Coke is a smokeless fuel and its use is increasing constantly in place of "raw" coal. As coke is produced in manufacturing coal gas, its use aids in fuel conservation.

Conservation of our natural resources, including coal, is one of the big problems of the age. Back in the days of the Civil War approximately 33,000,000 tons of coal were mined annually and the consumption of petroleum, which was then just coming into use, was about two-thirds of a gallon per person. Today, that would be less than one month's supply of coal and the use of petroleum has increased many thousand per cent.

Coal and oil supplies will not last forever and maximum efficiency must be derived from them.

Present Development:

In the little more than one hundred years since the first gas company was organized in Baltimore the manufactured gas industry of the United States has grown until today it ranks among the leading industries of the country.

Gas companies now serve more than half of this nation's population and are practically all under private management. Some gas companies serve one city and others serve a number of communities to supply gas at more reasonable rates.

If all of the employes of these gas companies and their families lived in one place, they would constitute a city of more than 400,000 inhabitants.

How Gas Consumption Increases:

The consumption of gas has increased steadily year after year, until now it is nearly four times what it was 20 years ago. In the last six years alone the use of gas has increased by 125,002,374,000 cubic feet, or approximately 37 per cent in the United States.

To make these billions of cubic feet of gas, the gas companies use more than 8,310,000 tons of bituminous coal, about 2,080,000 tons of anthracite coal, 3,320,000 tons of coke and 1,010,000,000 gallons of oil each year.

More gas is consumed today for cooking, heating water, illumination and other domestic uses than for any other single purpose. About 71.24 per cent of the gas sold is used in this way; 26.86 per cent is used for industrial and commercial purposes and 1.90 per cent for uses not classified. Use of gas for house-heating—gas-fired boilers in place of hot air furnaces and hot water or steam heating systems—is increasing rapidly.

While the big gas holders, the cylindrical shaped tanks which stand upright in big steel frames, are the most conspicuous feature of a gas plant, these holders are only the storage place for the gas as it is manufactured and awaiting use. There are buildings nearby where the gas is manufactured, and buried under the ground, throughout every city enjoying this service, are the mains which carry the gas to the consumers.

There were 86,800 miles of these gas mains in the United States in 1926, not counting the hundreds of thousands of miles of pipes which lead from the bigger mains to the homes or factories of consumers.

Owners of Gas Companies:

Gas companies and other utilities, such as electric light, telephone and street railway companies, are not owned by those employed to manage them, but by thousands of thrifty investors who have bought stocks and bonds with their savings. It is only through sales of these securities that funds are provided for building the plants for the service of the people.

These companies are regulated by state commissions in practically all of the States of the Union. These commissions fix the rates and supervise the service of the gas companies and other utilities. In Illinois the regulatory body is the Illinois Commerce Commission, which is a part of the state government.

Under the system of regulation by the state, gas companies and other utilities are permitted to earn a fair return on their investment. If their earnings are considered excessive at any time their rates are adjusted. If their expenses increase, as during the recent war period, when wages and the cost of materials exceeded normal costs, commissions authorize increased rates, to permit the earning of costs of production and a reasonable interest return on the value of the property used or usable in the business.

Neither gas companies nor any of the other public utilities are allowed to charge rates that are high enough to enable them to make further additions to their plants from profits. Extensions and additions must be built with new money raised by the sale of additional securities. These securities cannot be sold until the regulatory commissions have investigated and are satisfied that the money is to be spent for needed improvements.

Gas a "Natural Monopoly:"

The gas business is a natural monopoly because good and economical service is best assured by having only one gas company in a given territory. In other days some of the larger cities had two or more competing companies but experience proved the fallacy of the plan. Existence of more than one company to supply any utility service in a given territory means economic waste and duplication of investment, plants, offices, employes and general expense. Economic law has generally forced competing gas companies to consolidate.

All of Chicago, for example, is today served by The Peoples Gas Light and Coke Company, which is a consolidation of fifteen other gas companies. This company was incorporated under a special act of the state legislature, February 12, 1855, and was the second oldest of the combined gas companies. It acquired all competing companies by authority of an act of the legislature passed in 1897.

How Manufacturing Processes Change:

Gas originally was made by distilling coal, this being the method until 1887 when keen competition caused new processes to be developed. When the principal use of gas was for lighting with open flame burners, gas having a high candle power content was made. Gas engineers invented the carbureted blue gas process in which steam and an enriching material, usually naphtha, crude oil or a hydro-carbon is used with coke. The enriching material increased the lighting content of gas and later the mantle made possible a large volume of light with gas of a low candle power.

Gas now is used almost universally for heating purposes in homes and industries and now the important factor in gas is the calorific (heat) quality, measured in British thermal units, commonly signified as B.t.u's. One of these units is the amount of heat required to raise the temperature of a pound of water one degree Fahrenheit.

Principal Uses of Gas:

The practice of requiring a high candle power illuminating value is now almost obsolete and it has been abolished in Illinois. As more than 80 per cent of the gas sold today is used to produce heat, its heating qualities are more essential than candle power content. Gas is used to heat rooms, houses and even office and apartment buildings, and heat produced by gas is used widely for cooking, for heating water and in hundreds of different manufacturing processes where economical, clean heat is essential.

Even for lighting today, candle power does not matter, as practically all gas lighting is done with incandescent mantles.

Each year equipment for burning gas for heating purposes is being installed in thousands of homes and eventually this will be one of the biggest uses for gas, leaders in the industry believe. When the walls and roof of a house are insulated to prevent the escape of heat, it costs no more to heat with gas than it does with coal. As there are no ashes, no dirt to soil the furnishings, and the temperature of the house is uniform and controlled automatically, gas heating is becoming increasingly popular.

How Gas Is Made:

Coal gas and so-called carbureted blue gas are the two most common kinds of manufactured gas.

The series of operations connected with the preparation and distribution of coal gas embraces the process of distillation of the coal, condensation, scrubbing or washing, purification, measuring, storing and distribution to the mains from which the consumer's supply is drawn. As dif-

ferent kinds of coal vary greatly in their chemical constitution, there is a wide difference in their value and usefulness for the manufacture of gas.

An Interesting Experiment:

If the bowl of an ordinary clay pipe is filled with small fragments of bituminous coal, the top of the pipe closed with clay and the bowl placed in a bright fire, smoke may be seen to issue immediately from the pipe stem projecting beyond the fire. The smoke soon ceases and if a light then is applied the issuing gas burns with a bright, steady flame while a black, thin, tarry liquid also oozes from the stem. After this combustion there remains in the bowl a quantity of "char" or coke.

This simple experiment is, on a small scale, an exact counterpart of the process by which the distillation of coal is accomplished in the manufacture of coal gas. The thin, tarry liquid contains all of the wonderful by-products.

How Coal Gas Is Made:

In manufacturing coal gas, coal is heated in big retorts or ovens, made of iron, clay or brick. These are kept at a bright red heat. Care must be exercised to preserve the quality of the gas from sulphur compounds which are given off when the coke is overheated.

Upon leaving the retort, the gas is about the color of smoke and is, of course, at a higher temperature. It is necessary to reduce the temperature, which also reduces the bulk, and to remove whatever impurities it is carrying along with it. The first process of condensation is performed by having the gas pass through a series of water-cooled pipes, which rise from a trough partly filled with water. In this process, the gas is not only considerably reduced in temperature but the tar and ammoniacal liquor condense and drop to the bottom of the pipes. Here they encounter the water, the tar sinking to the bottom and the ammoniacal liquor floating on top.

The progress of the gas would be impeded and a back-pressure on the retorts created by the obstacles it must pass unless it were helped on its way. Engines, called exhausters, are therefore installed, which draw the gas from the condensers and force it to the storage tank.

The gas next passes through a scrubber which removes from it all that remains of ammonia, sulphureted hydrogen, and other gas impurities. The agencies used are partly mechanical and partly chemical. The gas first is passed through a scrubber, ordinarily a high tower or a hollow column. It is filled with either scrap tin or coarse shavings, laid on boards arranged in tiers. The gas works its way through these obstructions, leaving tar and other impurities on the sharp edges it encounters. It then passes on to the purifiers.

How Impurities Are Removed:

Purifiers are flat iron boxes generally arranged in sets of four. Three of them are placed so the gas passes through them in succession while the fourth is being renewed. The boxes are filled with shavings which have been soaked in a solution of oxide of iron. The oxide serves the purpose of decomposing sulphureted hydrogen, the portion of the sulphur forming a sulphide with the iron. When a sufficient quantity of gas has passed, the box is opened and the contents are removed and exposed to the air, under which condition they combine with the oxygen and again become fitted for use as a purifier.

The gas is now ready for use and is passed on through the plant meter and stored in the gas holders.

How Carbureted Water Gas Is Made:

Carbureted water gas is manufactured in three round steel towers, the generator, the carbureter and the superheater.

About three-fourths of the gas is generated or manufactured in the generator which is lined with fire brick. The generator is connected with a similarly shaped tower—the carbureter. This part, also, is lined with fire brick, and is almost filled with layers of bricks placed criss-cross, thus forming a sort of honeycomb arrangement. The carbureter serves the same purpose in a gas plant as it does in an automobile, that is to gasify a liquid. But, in the gas works, gas-oil is used, while in an automobile gasoline is used. The carbureter is connected to a third steel tower also honeycombed with brick. This is the superheater and is used to complete the work of the carbureter.

The Part Steam Plays:

The generator is filled with a good quality of coke and the fuel bed is ignited. Air is blown through the apparatus for from two to four minutes or until the fuel bed is white hot. The hot gas from the burning fuel in the generator passes through the honeycombs of the carbureter and superheater.

At this time the air is shut off, and steam is sent into the generator. As the steam passes through the hot coke, it reacts chemically with the fuel, producing two gases, carbon monoxide and hydrogen, which pass into the top of the carbureter.

Because this gas mixture has a low heating value, it must be "enriched." To do this, gas oil is sprayed into the top of the carbureter. As this oil passes through the honeycomb of hot bricks in the carbureter and superheater, it is broken up into gases which have a high heating value. The gases from the oil and coke or coal mix and are now ready to be purified.

The hot crude carbureted blue gas passes from the superheater through water in the wash box where some of the tar is removed and the gas

cooled. From the wash box, the gas passes through the hot scrubber, coming into intimate contact with hot water which removes most of the tar without removing the enriching vapors. Gas leaving the hot scrubber contains much water vapor which must be removed by cooling the gas in the condenser. From the condenser, the gas passes to the relief holder, which is a tank holding from a few thousand to several thousand cubic feet of gas, depending upon the size of the plant. The tank, or holder, equalizes the flow of gas through the purifying apparatus.

From the relief holder a pump, the exhauster, forces the impure gas through the shavings scrubbers—towers which are filled with wood shavings. The remaining droplets of tar stick to the shavings.

All Impurities Removed:

However, the gas still contains hydrogen sulphide, a gas which has a bad odor and, unless removed, might ruin the gas range and the finish of the woodwork in the home. So the gas is forced through purifiers and shavings keep the iron oxide porous so that the gas will be brought into intimate contact with the oxide. As the gas passes through the oxide, the hydrogen sulphide in the gas unites chemically with the oxide and produces iron sulphide, a solid which remains in the purifying box, while the pure gas passes on, ready for use.

The By-Products of Gas:

The manufacture of gas yields many by-products from which are made commodities used daily by everyone. Some of these valuable by-products are: Drugs, fertilizers, tar, ammonia, colors for dyestuffs, moth balls (naphthalene), photographic chemicals, carbons for electric arcs, explosives, materials for perfumes, coke and saccharin.

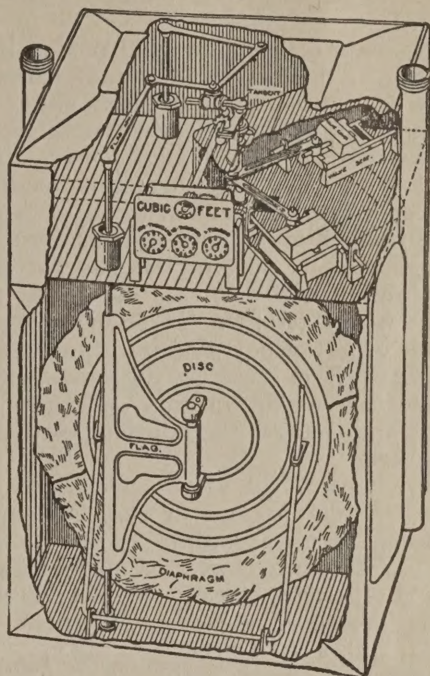
The common method of burning coal destroys many valuable by-products which are saved when coal is used for making gas. As only about 16 per cent of the soft coal mined in the United States is "coked," or used in the manufacture of gas, it is easy to understand that the consumption of coal by unscientific methods is wasteful and extravagant, not only producing smoke but destroying valuable contents.

If coal is burned in the open-air or in a stove or furnace, nothing is left but ashes. In making coal gas, coal is heated in a closed retort where the oxygen of the air cannot reach it. After the gas has been driven off, carbon or coke remains, and is used in making carbureted blue gas and for many other purposes.

Chemists also have found thousands of ways to use the tar, ammonia, sulphur and other products removed from the gas in the purifying processes, and the uses of these three products cover a wide field from the explosives of the battlefield to the perfumes of the society ballroom.

The Gas Meter:

The gas used by every customer is measured by the gas meter, one of the simplest and most accurate of measuring devices. It was invented by William Richards in 1844 and was so simple that no substantial improvement has been made upon it since.



A Gas Meter

A meter that is properly located and protected from extreme heat and cold will measure gas accurately, day and night for years without requiring attention. In spite of this evidence of reliability, most gas meters are examined periodically. The Illinois Commerce Commission, which regulates the gas companies and other utilities of this state, requires that gas meters be removed from the customers' premises and tested for accuracy every seventh year of service.

The meter is divided into two parts, the upper containing the registering apparatus and the lower containing two diaphragms or bellows. The lower part is divided by a vertical metal partition, each compartment containing a bellows.

How the Meter Operates:

A meter operates as human lungs. The bellows are of leather and inhale and exhale gas just as the human lungs take in and send out air, but the bellows work one after the other; that is, when one is inhaling gas from the mains the other is exhaling gas into the house pipes.

Gas must be turned on at a burner or appliance to set the gas meter in operation. Hence, the consumer alone is the "engineer" of the meter.

When the burner or appliance is lighted pressure is reduced simultaneously at the outlet of the meter and immediately gas at the inlet side of the meter starts to flow toward the outlet port. In its flow through the meter the gas must pass through channels and chambers and in so doing causes the diaphragms to fill and empty, the valves to move back and forth on their seats and the index to register the volume of gas which has passed.

The gas enters the meter and passes through an opening in the upper horizontal partition to the valve enclosure. Then it enters either of two sheepskin diaphragms or bellows, or the compartment surrounding it. The gas enters the port leading into the diaphragm which is opening and furthers continued movement of the valves.

The action of filling and opening one of the diaphragms expels part of the gas surrounding the diaphragm in the compartment and the expelled gas is directed by a "D" slide valve through the center or outlet port and into the outlet pipe, from whence it is used by the customer. The diaphragm movement in this operation rotates the crank and changes the relative position of the valve covers.

Gas flowing into the valve enclosure is distributed into the diaphragms or case compartments surrounding them, according to the position of the valves. Pressure is exerted on the diaphragm or case compartment ready to receive the gas, and this pressure reverses movement of the affected diaphragm and expels the gas in the diaphragm or compartment, the gas passing through the same port by which it entered. The gas then continues through the center valve port and thence into the outlet port as in the first instance.

The action of filling one diaphragm may be said to be included in one phase of a cycle, the emptying a second phase and, as the operation of the second diaphragm on the opposite side of the partition is exactly the same, we have four phases to one cycle or complete operation of the meter during which the valve crank makes one revolution.

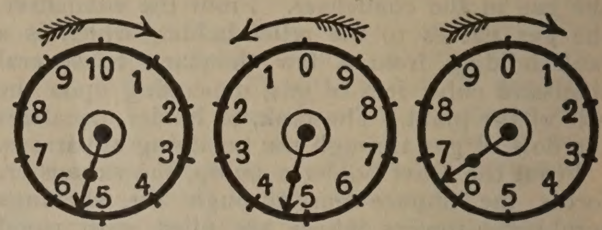
On the crank is a worm to which is geared a spindle which also is connected with the index—the three small dials familiar to everyone—on the face of the meter. The gas meter reader can tell how much gas has passed through the meter by reading the dials.

Features of the Gas Meter:

The gas meter used by every consumer embraces four outstanding features. The meter is simple in operation, is accurate, is controlled only by the consumer of the gas passing through it and assures a uniform supply of gas because of its double-bellows and compartment arrangement.

How to Read Your Meter:

Anyone can easily learn to read a gas meter and check the amount of gas used through it each month. Suppose the hands of the dials are pointed like this: then two things must be done.



First—reading from left to right, take the smaller of the two figures next to the hand on each dial. On the dials shown above, these are 546. Then two ciphers are added to these figures (in this case it is 54,600) and from the figures thus obtained is subtracted the meter reading of the previous month as shown on the last gas bill. The result is the cubic feet of gas used during the month.

HOW TO USE THIS BULLETIN:

There are four ends of speech, or four purposes for which men express themselves: first, to make an idea clear; second, to make an idea impressive; third, to make people believe; and fourth, to cause people to act.

Suggested topics for theme writing; oral english and current topics discussions.

1. **To Make an Idea Clear:**

   Describe the manufacture of gas.
   Describe the operation of a gas meter.

2. **To Make an Idea Impressive:**

   Give the difficulties surmounted in introducing gas lighting.
   Tell what gas has done for industry.
   Describe the future made possible by extensive gas use.

3. **To Convince:**

   Debate. Resolved: That Manufactured Gas is the Most Efficient Modern Fuel.

4. **To Secure Action:**

   We should make all our large cities smokeless.

   Gas will conserve our coal resources.

   Miscellaneous Topics:

   1. The men who have made manufactured gas practical.
   2. What we can do with the by-products of gas.
   3. The greater cleanliness of using gas.